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AGGREGATE RESOURCES IN THE RURAL MUNICIPALITY OF RUSSELL

RESOURCE MANAGEMENT AND PIT REHABILITATION PROPOSAL FOR LAND USE PLANNING

DEPARTMENT OF ENERGY AND MINES
MINERAL RESOURCES DIVISION

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Abstract

Aggregate resources are an essential commodity required for present and future construction activities in Manitoba. This non-renewable resource, under present engineering technology, has no suitable substitute for most end uses. Aggregate is characterized by a low intrinsic value, a high bulk, and a delivered price that is highly sensitive to transportation costs. The economics of production dictate that mineral extraction and processing be located as close to the construction project as economically feasible. In light of the general scarcity of quality aggregate, safeguards are needed to conserve the existing supply.

This resource management proposal has been compiled in order to promote aggregate resource management as well as to facilitate regional land use planning activities in the R.M. of Russell. The report contains background information concerning potential future potash development in the planning district as well as background information regarding the conservation of regional aggregate deposits.

The aggregate resource base of the Rural Municipality of Russell is located in Quaternary outwash, terrace, and esker deposits. A total of 16 deposits were identified containing an estimated 122 million cubic metres of which 4 deposits containing 15 534 700 have been designated for a Stop Development Status. It is recommended that all deposits assigned to Stop Development Status be protected from conflicting surface land uses until the resource has been used to depletion.

TABLE OF CONTENTS

		Page
1.1	General Statement	1
1.2	Objectives	2
1.3	Significance of Aggregate Resource Management	2

SECTION 2
GEOLOGY OF THE RURAL MUNICIPALITY OF RUSSELL

2.1	Introduction	6
2.2	Bedrock Geology	6
2.3	Quaternary Geology	11
2.3.1	Physiography	12

SECTION 3
AGGREGATE RESOURCES IN THE RURAL MUNICIPALITY OF RUSSELL

3.1	Introduction	16
3.2	Aggregate Resource Potential in the Rural Municipality of Russell	16
3.3	Demand for Sand and Gravel	18
3.4	Recommended Development Status of Mineral Resource Areas	20
3.5	Conclusion	22

TABLES

Table 1.1	Sand and Gravel end uses in Manitoba	3
Table 2.1	Summary of Geologic Units in the Russell-Shoal Lake area	13
Table 3.1	Estimated Annual Demand for Sand and Gravel in the Rural Municipality of Russell	19
Table 3.2	Recommended Development Status of Mineral Resource Areas	22

FIGURES

Figure 2.1	Geological Formations in Manitoba	7
Figure 2.2	Structure Cross-section Southwestern Manitoba	10
Figure 2.3	Potential Hydrostratigraphic influences in the Russell-Shoal Lake Area	14

MAPS

Map 1	Aggregate Resource Potential in the Rural Municipality of Russell	Appendix IV

SECTION 1

INTRODUCTION

1.1 GENERAL STATEMENT

Aggregate resources (sand, gravel and crushed rock) are an essential commodity required for present and future construction activities in Manitoba. This resource, under present engineering technology, has no suitable substitute for most end uses. Typical construction end uses for aggregate include engineering projects such as transportation facilities, hospitals, homes, educational facilities, etc. Aggregate is characterized as a high bulk, low unit value, large volume mineral commodity that replaces more expensive construction materials. The restricted supply of regional aggregate resources due to resource scarcity, depletion, or sterilization can act as an economic constraint on present and future construction requirements. The problem of limited resource availability is compounded by increased development pressure around urban centres and expanding aggregate requirements to support construction requirements of a growing economy and population.

The primary objective of this resource management proposal is to provide technical input concerning sand and gravel resources conservation as a component in the R.M. of Russell District Development Plan. The management of sand and gravel resources, based upon Provincial Land Use Policy #13, is important to ensure that a supply of aggregate is available to meet the required needs of the construction industry both present and future. The information and resource planning recommendations contained herein will serve as a guide to formulating policies in the development plan concerning aggregate resource management and surface mining as a land user.

1.2 OBJECTIVES

The objectives of this aggregate mineral resource management report are:

(1) To outline the primary sources of information for aggregate mineral resource management.

(2) To provide a general geologic history of the R.M. of Russell.

(3) To provide a comprehensive resource inventory of aggregate in the R.M. of Russell.

(4) To provide a general economic analysis of the regional supply and demand conditions over a 25-year planning horizon.

(5) To outline the significance of aggregate resource conservation to Municipal Councils, Local District Planning Boards, regional land use planners, industry and the public.

(6) To outline the significance of potential potash development in the R.M. of Russell.

(7) To provide information concerning aggregate resource extraction as a surface land user.

(8) To provide statutory requirements under the Mines Act concerning mineral dispositions and rehabilitation requirements of depleted pits.

(9) To provide aggregate resource planning recommendations based upon Provincial Land Use Policy #13, Manitoba Regulation 217/80 of the Planning Act.

1.3 SIGNIFICANCE OF AGGREGATE RESOURCE MANAGEMENT

The aggregate resource extraction industry is concerned with the removal of naturally occurring materials from beneath the earth's surface and normally includes some form of processing required in order to meet the engineering specification of the end use. The construction aggregate industry is, by volume produced, the largest of the surface mining industries in

TABLE 1.1

Sand and Gravel End Uses in Manitoba

Construction Type	End Use
Road construction	subbase base traffic (surface) gravel shoulders culvert fill maintenance (pit run) ice control
Concrete Aggregate	road surface dams foundations building ready-mix sidewalks pre-cast blocks, tiles mortar grout
Asphalt Aggregate	road surfacing parking lots
Railway Construction	subbase ballast
Fill	sewer and water pipe bedding septic field construction rip-rap dam construction

Manitoba today. The common mineral aggregates (sand, gravel and crushed rock) consist of relatively inert fragments, and their primary function as a construction material is to provide for bulk; consequently, aggregates should be relatively abundant and cheap. For example, aggregates occupy between 70 to 80 per cent of the volume of concrete and the quality of local aggregate deposits significantly effect the quality of local concrete available.

Aggregate as a resource is characterized by a low intrinsic value, high bulk, and a delivered price that is highly sensitive to transportation costs. The market characteristics of the resource dictate that mineral extraction and processing be located as close to the construction site as economically feasible. Construction economics and engineering technology dictate that the resource must be readily available in large quantities of high quality (chemically and physically durable) variably graded, and be delivered at a relatively cheap price. The delivered price of the commodity is highly sensitive to transportation costs, and by sterilizing aggregate deposits prior to depletion can add significant increased local construction costs due to increased haulage distances required.

Society faces, at the present time, increasing population levels and expanding economic growth rates which require, in the long run, significant volumes of quality aggregate material. To provide the present and future generations with homes, transportation facilities, educational institutions and employment opportunities, society must build and maintain increasing numbers of physical facilities. As aggregate demand is highly inelastic and tied closely to activity in the construction sector, the long-term demand for aggregate is anticipated to at least grow at the same rate as population growth; however, over time, if economic activity increases coupled with the fact that roads and buildings will need replacing, projections of future aggregate requirements may increase significantly greater than population growth rates. Because aggregate is a non-renewable resource one important resource management problem facing the construction industry is the depletion of high quality deposits over time.

Aggregates are given a quality classification dependent upon their chemical and physical durability required for a specific end use. In order for a pit or quarry to supply the required material for a construction project it must be of suitable quality defined by the end use engineering specification. For example, Manitoba Department of Highways requires engineering specifications that a gravel resource must comply with in order to be utilized for asphalt, base course or surfacing gravel.

In general terms the aggregates are produced at the pit or quarry (supply point) and transported to the construction site (demand point) where they are utilized for construction of buildings, roads, bridges, and other engineering projects. The delivered price per tonne reflects the cost of the material, processing, transportation costs, fixed costs of amortizing and reclamation. In certain instances unprocessed material (pit run) is sold and used for fill or sub-base material.

Sand, gravel and crushed stone can be used interchangeably when their quality and delivered price are comparable. Sand and gravel is produced from open pits located in a gravel deposit and processing normally consists of washing, screening and crushing to various sizes and stockpiling. Crushed stone, however, is produced from open quarries in the bedrock and processing includes drilling, blasting, crushing, screening, washing, and stockpiling. Crushed stone is generally more expensive to produce than sand and gravel due to the increased processing and handling required.

SECTION 2

GEOLOGY OF THE RURAL MUNICIPALITY OF RUSSELL

2.1 INTRODUCTION

This section will briefly describe the surficial geology as well as the underlying bedrock geology in the Rural Municipality of Russell. Included are a brief description of the historical geology, description of the stratigraphy and, most importantly, a description of the surficial geomorphology. The primary objective of Section 2 is to provide a geologic perspective in order to define the economic potential of each geologic unit. Due to the stratigraphic thickness and variability of the bedrock overlying the basement Precambrian granites, particular emphasis shall be given to the Devonian (potash), Cretaceous (shale), and the aggregate-bearing units located in the Quaternary deposits (Fig. 2.1).

2.2 BEDROCK GEOLOGY

The geology underlying the Rural Municipality of Russell consists of basement Precambrian granites and granite gneisses that are overlain by a thick stratigraphic column of Ordovician, Silurian, Devonian, Mississippian, and Jurassic carbonates and related rocks which in turn are overlain by Cretaceous shales and sandstone. Quaternary deposits of till, clay, sand and gravel blanket the bedrock.

PRECAMBRIAN

The basement Precambrian rocks underlying the Rural Municipality of Russell primarily consist of late intrusive granites and granite gneisses of Archean age. These basement Precambrian rocks occur as part of a large

ERA	PERIOD	EPOCH	FORMATION	MEMBER	MAX. THICK (m)	BASIC LITHOLOGY	Symbol	STOP
CENOZOIC	QUATERNARY	RECENT				TOP SOIL, DUNE SANDS		
		PLEISTOCENE	GLACIAL DRIFT		140	CLAY, SAND, GRAVEL, BOULDERS, PEAT		
	TERTIARY	PLIOCENE MIOCENE OLIGOCENE EOCENE					T	
		PALEOCENE	TURTLE MTN.	PEACE GARDEN GOODLANDS	120	SHALE, CLAY AND SAND. LIGNITE BEDS LOCATED ONLY IN TURTLE MOUNTAIN		
MESOZOIC	CRETACEOUS	UPPER CRETACEOUS	BOISSEVAIN		30	SAND AND SANDSTONE, GREENISH GREY, LOCATED ONLY IN TURTLE MOUNTAIN	B	
			RIDING MTN.	[illegible]	310	GREY SHALES—NON-CALC. LOCAL IRONSTONE BENTONITE NEAR BASE. GAS FOUND	RM	3
			VERMILION RIVER	PEMBINA	155	SHALE DARK GREY CARBONACEOUS NON-CAL BENTONITE BANDS	VR	1
				BOYNE		SHALE GREY SPECKLED CALC. BENTONITIC SLIGHTLY PETROLIFEROUS		2
				MORDEN		SHALE DARK GREY NON-CALC. CONCRETIONS, LOCAL SAND AND SILT	K	4
			FAVEL		40	GREY SHALE WITH HEAVY CALCAREOUS SPECKS BANDS LIMESTONE AND BENTONITE	F	
		LOWER CRETACEOUS	ASHVILLE ASHVILLE SAND		115	SHALE, DARK GREY, NON-CALC. SILTY "SAND ZONE" 27m F.G. QTZ. S. OR SS.	A	
			SWAN RIVER		75	SANDSTONE AND SAND, QTZ. PYRITIC SHALE—GREY, NON-CALC.	SR	
	JURASSIC	UPPER JURASSIC	WASKADA		200	BANDED-GREEN SHALE AND CALC.SANDSTONE		
			MELITA			BANDS OF LIMESTONE, VARI-COLORED SHALE	J	
		MIDDLE JURASSIC	RESTON		45	LIMESTONE, BUFF, AND SHALES, GREY		
			AMARANTH	UPPER: EVAPORITE	45	WHITE ANHYDRITE AND/OR GYPSUM AND BANDED DOLOMITE AND SHALE		5,6
				LOWER: RED BEDS	40	RED SHALE TO SILTSTONE-OOLOMITIC		
	TRIASSIC							
PALEOZOIC	PERMIAN	(?)	ST. MARTIN COMPLEX		300	CARBONATE BRECCIA, TRACHYANDESITE (CRYPTO-EXPLOSION STRUCTURE)	P	
	PENNSYLVANIAN							
	MISSISSIPPIAN		MADISON GROUP: CHARLES		20	MASSIVE ANHYDRITE AND DOLOMITE		
			MADISON GROUP: MISSION CANYON	MC—5 MC—4 MC—3 MC—2 MC—1	120	LIMESTONE—LIGHT BUFF, OOLITIC, FOSS, FRAG., CHERTY, BANDS SHALE AND ANHYDRITE. OIL PRODUCTION		
			MADISON GROUP: LODGEPOLE	FLOSSIE LAKE WHITEWATER LAKE VIRDEN [illegible]	180	LIMESTONE & ARG. LIMESTONE LIGHT BROWN AND REDDISH MOTTLED. ZONES OF SHALEY, OOLITIC, CRINOIDAL & CHERTY. OIL PRODUCTION		
			BAKKEN	UPPER MIDDLE LOWER	20	2 BLACK SHALE ZONES — SEPARATED BY SILTSTONE OIL SHOW HIGH R.A. KICK.		
	DEVONIAN		ELK POINT G.: LYLETON		38	RED SILTSTONE AND SHALE DOLOMITIC.		
			BASE GROUP: NISKU		40	LIMESTONE & DOLOMITE, YELLOW-GREY FOSS. POROUS. SOME ANHYD.		
			BASE GROUP: DUPEROW		170	LIMESTONE & DOLOMITE, ARG. & ANHYDRITIC IN PLACES		
			MAN GROUP: SOURIS RIVER 1-ST RED		120	CYCLICAL SHALE, LIMESTONE & DOLOMITE, ANHYDRITE	SR	
			MAN GROUP: DAWSON BAY 2-ND RED		65	LIMESTONE & DOLOMITE, POROUS, ANHYDRITE—LOCAL SHALE RED & GREEN	D DB	
			ELK POINT G.: PRAIRIE EVAP.		120	SALT POTASH & ANHYDRITE, DOLOMITE INTER-BEDDED.		
			ELK POINT G.: WINNIPEGOSIS		75	DOLOMITE, LIGHT YELLOWISH BROWN REEFY.	W	
			ELK POINT G.: ELM POINT			LIMESTONE—FOSS, HIGH CALCIUM	EP	7,8
			ELK POINT G.: ASHERN		12	DOLOMITE AND SHALE—BRICK RED	A	
	SILURIAN		INTERLAKE GROUP		135	DOLOMITE YELLOWISH—ORANGE TO GREYISH—YELLOW FOSS. SILTY ZONES	S	
	ORDOVICIAN		STONEWALL		15	DOLOSTONE, GREYISH YELLOW, BEDDED.	S	
			STONY MOUNTAIN	WILLIAMS GUNTON	30	DOLOMITE—YELLOWISH—GREY SHALEY	SM	
				PENITENTIARY		DOLOMITE—BUSKY—YELLOW FOSS.		
				GUNN	20	SHALE NEDOGREEN FOSS. LIMESTONE & SANDS.		
			RED RIVER	FORT GARRY SELKIRK CAT HEAD DOG HEAD	170	DOLOMITIC LIMESTONE, MOTTLED AND DOLOMITE	O RR	
			WINNIPEG	UPPER UNIT	60	SHALE, GREEN, WAXY, SANDSTONE INTERBEDDED.	W	
				SANDSTONE		SAND, SANDSTONE, QUARTZOSE.		
	CAMBRIAN		DEADWOOD		60	SAND, BLACK TO GREEN-GREY WAXY, GLAUCONITIC SILTSTONE & SHALE, GREEN-GREY TO BLACK, VERY EDGE OF S.W. MANITOBA ONLY.		
PRECAMBRIAN						ACID & BASIC CRYSTALLINES & METAMORPHICS		

Figure 2.1 Geological formations in Manitoba

regional basin, termed the Williston Basin, that greatly influenced the depositional framework of the overlying sedimentary rocks through geologic time.

ORDOVICIAN

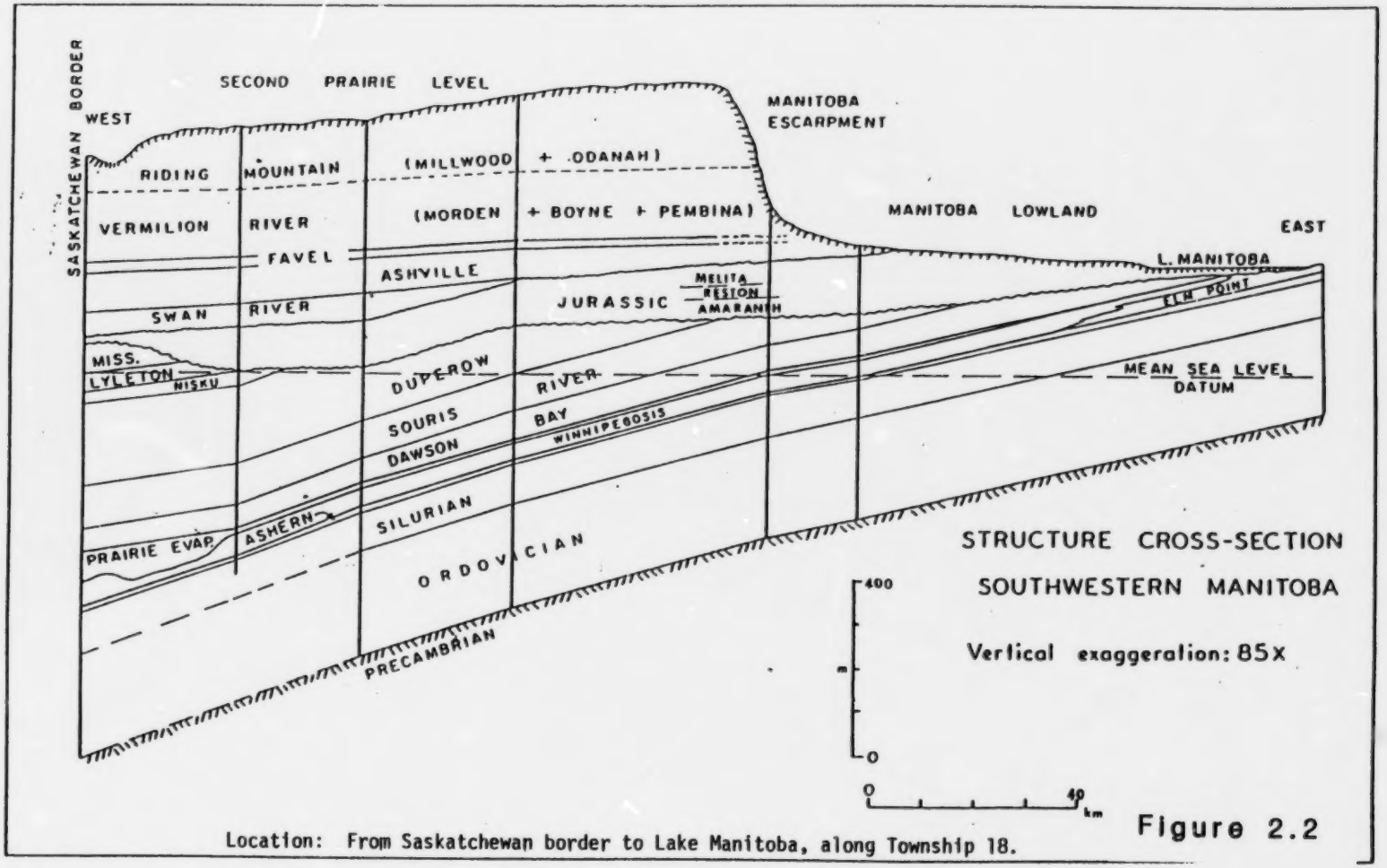
The Ordovician strata unconformably overlie the basement Precambrian rocks and have been subdivided into four geologic formations including the Winnipeg, Red River, Stony Mountain, and Stonewall Formations. The Ordovician strata consists of a basal sandstone unit overlain by various geologic members predominantly comprising dolomite with minor interbedded shale. McCabe and Barchyn (1982) suggested that throughout Ordovician time the interbedding of calcareous and dolomitic lithologies indicates a cyclical fluctuation of depositional conditions (eustatic) that has been superimposed upon the overall pattern of basin subsidence.

SILURIAN

The Silurian strata (Silurian Interlake Group) consists predominantly of dolomite that was deposited in a relatively stable tectonic framework. Silurian strata are relatively uniform and consist of micrite to interclastic and stromatolitic dolomites with scattered fossil fragmentals. The monotonous sequence is interrupted by a number of thin sandy argillaceous marker beds.

DEVONIAN

The Devonian strata consists predominantly of dolomites and limestones with occurrences of interbedded salt, potash, and anhydrite. The Devonian stratigraphic section has been subdivided into eight geologic formations including the Ashern, Elm Point, Winnipegosis (potash), Dawson Bay, Souris River, Duperow, Nisku, and Lyleton Formations (see Fig. 2-1).



Location: From Saskatchewan border to Lake Manitoba, along Township 18.

Figure 2.2

Devonian deposition was marked by a major change in tectonic framework in comparison with the underlying Silurian and Ordovician rocks (McCabe and Barchyn, 1982). The depositional influence of the Williston Basin was reduced by the Elk Point Basin, centering in south central Saskatchewan, which became the major influence. Because of extreme late Paleozoic erosion as well as complex facies encountered in Devonian strata the depositional trend has not been clearly defined to date.

MISSISSIPPIAN

Mississippian strata, which forms the uppermost part of the Paleozoic carbonate sequence, consists predominantly of limestone with occurrences of shale, dolomite, and anhydrite (see Fig. 2.1). The Mississippian stratigraphy has been subdivided into four geologic formations, including the Bakken, Lodgepole, Mission Canyon, and Charles Formation, and to date most of Manitoba's oil production has come from Mississippian rocks. The oil is derived from porous fragmental beds near the middle of the Lodgepole Formation. One of the significant factors controlling oil production and accumulation is the pre-Jurassic erosion surface that resulted in extensive dolomization of the underlying limestones causing a dense impermeable zone that acts as a cap for the reservoir rock.

JURASSIC

The Jurassic strata consists of interbedded shale, limestone, and gypsum and have been subdivided into four geologic members including Amaranth, Reston, Melita, and Waskada Formations (see Fig. 2.1). The basal Amaranth formation consists of a lower unit of shale overlain by anhydrite-gypsum. This unit has been mined near Amaranth. Manitoba (gypsum), for usage in wallboard and cement production.

CRETACEOUS

The Cretaceous bedrock directly underlies the Quaternary deposits of till, clay, sand, and gravel in the Rural Municipality of Russell. The Cretaceous strata consists predominantly of shale with interbedded sandstone and has been subdivided into the Swan River, Ashville, Favel, Vermillion River, Riding Mountain, and Boissevain Formations.

The basal portion of the Cretaceous stratigraphy unconformably overlies the Jurassic Waskada Formation. Fragments of lignite located near the base of the Lower Cretaceous Swan River Formation suggest that those beds were deposited in a terrestrial environment; however, the presence of glauconite interbeds in the upper part of the Swan Riyer Formation indicate a predominantly marine environment. Erosion resulted during the terrestrial period causing the development of an extensive deeply incised drainage pattern.

The deposition of the overlying Cretaceous strata occurred in a major epicontinental sea that flooded the Western Interior Basin. The seas encroached from both the Arctic Ocean and from the Gulf of Mexico until they merged during Cretaceous time.

2.3 QUATERNARY GEOLOGY

During the past 4.5 billion years of earth history climatic conditions have changed many times. For most of geologic time since the Precambrian warm tropical conditions have prevailed over North America, including Manitoba. However, during the past several million years North America has been experiencing comparably colder climates and has been subjected to extensive glacial ice cover.

The most recent period of climatic cooling began approximtely 75,000 years ago and ended 8,000 years ago. During this period glaciers did not cover all of North America but rather fluctuated back and forth between the Artic and more southerly areas. The last glacial episode, termed the Wisconsin Period, is responsible for most of the present-day glaciated landscape.

The stratigraphy in the Rural Municipality of Russell (see Fig. 2.2) includes two till formations that are pre-Wisconsinan in age as well as one glacial till (Minnedosa Formation) that is early Wisconsinian in age. The last glacial episode of the Wisconsinan period deposited the Lennard Formation with the associated drumlins, flutings, eskers and corrugated moraines indicting a southeasterly advance. During this time Lake Souris existed near the ice front with the Pipestone Spillway feeding glacial meltwater into it. Later, during the withdrawal of the ice the Qu'Appelle Spillway and later the Assiniboine Spillway became exposed and transported glacial meltwater into Lake Agassiz. Eventually, as the ice withdrew from the area meltwater quantities slowly waned forming successively lower terraces.

2.3.1 PHYSIOGRAPHY

There are three major physiographic regions in the Rural Municipality of Russell including a till plain, a large river valley (Assiniboine) and an area of outwash plain.

TILL PLAIN

The till plain is the major physiographic unit in the Rural Municipality of Russell. Till plains are characterized by a flat to gently irregular surface and are marked by randomly oriented ridges, knolls and depressions. The till plain displays local relief of up to 10 m and slopes gently toward the Assiniboine River where it drops from an elevation of 520 feet above sea level near Binscarth to approximately 460 feet above sea level at the edge of the Assiniboine Valley. The area around Binscarth contains a concentration of drumlinoid ridges and flutes oriented in a NW/SE direction, and to the west of Binscarth shale bedrock (Cretaceous) occurs as outcrops or is overlain by a thin till veneer.

AGE	UNIT	LANDFORM	COMPOSITION
Postglacial	Alluvium	Flood plains	silt, sand, organics
	Eolian Material	Sand dunes	sand
	Organics	Sloughs, depressions	organics, peat, muck
	Colluvium	Valley sides	shale, till, gravel
Proglacial	Outwash	Plains, terraces	sand and gravel
Glacial	Ice-Contact Drift	Kames, eskers	sand, gravel, till, silt
	Moraine Plateaux	Moraine Plateaux	silt, clay, till
	Lennard Formation	Till plain	sandy silt till
	Kames and Outwash	Buried	sand and gravel
	Minnedosa Formation	Till plain	sandy silt till
	Shell Formation*	Buried	sandy silt till
	Largs Formation*	Buried	clayey silt till
Cretaceous	Riding Mountain Formation	Bedrock	Shale

* = not exposed in study area

Table 2.1 Summary of Geological Units in the Russell-Shoal Lake area

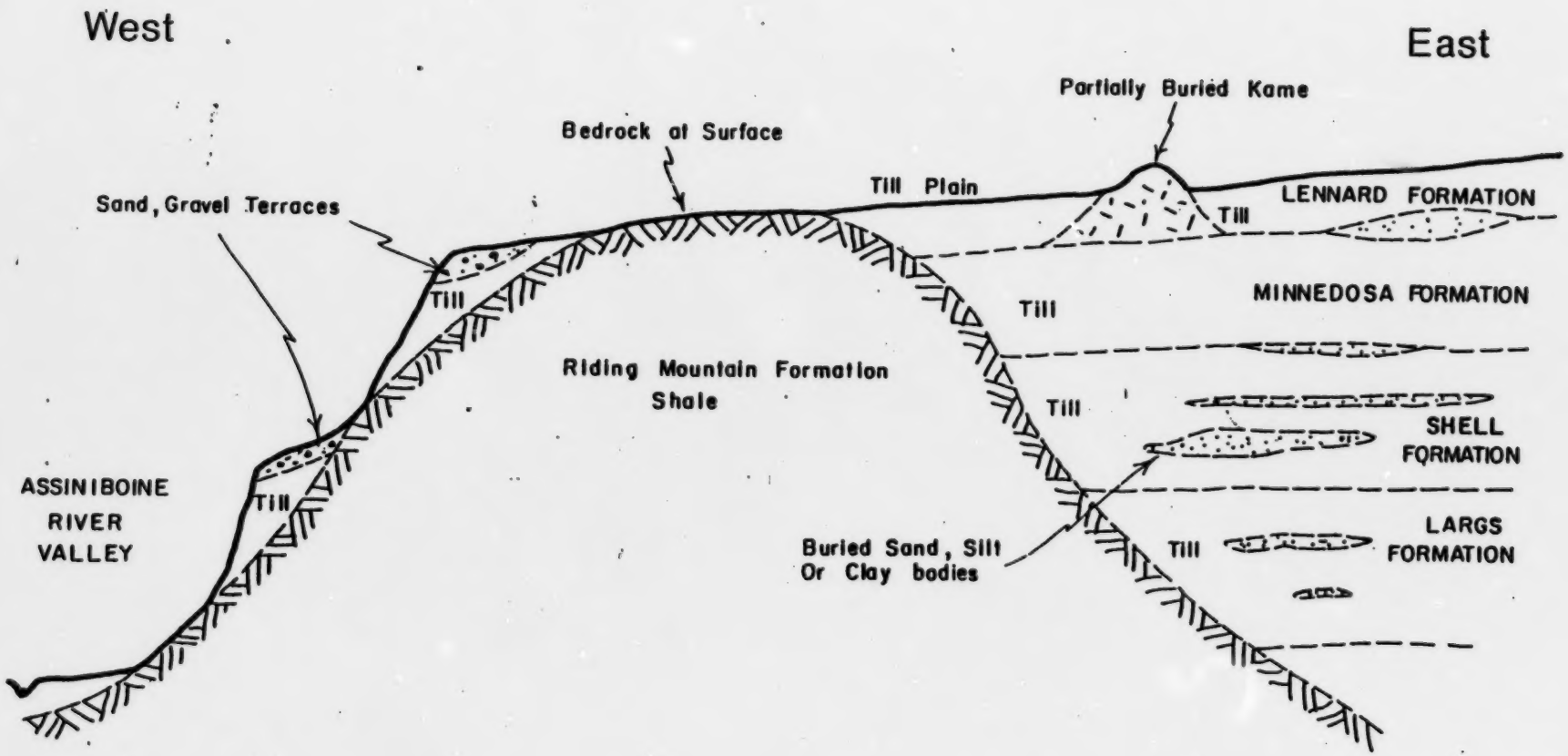


Figure 2.3 **Potential Hydrostratigraphic Influences In The Russell - Shoal Lake Area**

ASSINIBOINE RIVER VALLEY

The Assiniboine River Valley is a striking topographic feature that bisects the Rural Municipality of Russell. The valley can exhibit up to 60 m relief and varies from 1 to 3 km in width. The valley is characterized by steep sides with a flat bottom and contains large terraces in parts of the valley. The Assiniboine River is an underfit stream located in a former glacial meltwater channel.

OUTWASH PLAIN

An area of outwash plain is located in the southwestern portion of the Rural Municipality of Russell. The plain occurs at approximately 465 m above sea level, consists predominantly of sand and gravel, and is generally flat. Sand dunes have developed in portions of the plain.

SECTION 3.0
AGGREGATE RESOURCES IN
THE RURAL MUNICIPALITY OF RUSSELL

3.1 INTRODUCTION

The objective of Section 3 is to provide detailed background information in order to develop a resource management policy concerning aggregate mineral extraction for the Rual Municipality of Russell Development Plan. The aggregate resource planning recommendations provided, based upon Provincial Land Use Policy #13, reflect the general nature of the supply and demand relationship over a projected 25-year planning horizon. Specific resource topics include general information on the market characteristics of aggregate, end use requirements, aggregate bearing deposits, and resource planning recommendations.

3.2 AGGREGATE RESOURCE POTENTIAL IN THE RURAL MUNICIPALITY OF RUSSELL

The sand and gravel resources in the Rural Municipality of Russell are shown on Map 1 (in pocket). The resource information concerning sand and gravel is based on a geological consulting report prepared by Gartner Lee and Associates Ltd. (1983) prepared for Manitoba Energy and Mines. A total of 16 deposits were identified (Deposits 12201 - 12216), and the total volume before depletion was estimated to be 122 million cubic metres of granular material.

The majority of the aggregate potential in the R.M. of Russell is located in Deposit 12211. This deposit contains an estimated 98,892,000 cubic metres of medium quality gravel but the deposit is large and thin. Other significant gravel deposits are 12210 and 12213. These deposits contain 11 787 000 cubic metres and 6 532 500 cubic metres of aggregate, are fluvial in origin, and offer much future mining potential. The remaining deposits possess limited resource potential except 12204 which has been extensively mined. Gartner Lee and Asociates (1983) identified 4 types of aggregate-

bearing deposits including outwash plains, flurral terraces, meltwater channels and esker/kame complexes.

OUTWASH PLAINS

Outwash plains are relatively flat surface deposits consisting of sand and gravel which are not confined by a river valley. These deposits represent the initial proglacial flood of meltwater and can be transitional to the fluvial terraces which are confined to the river valley. Outwash plains exhibit three main characteristics, that is they occupy large areas, are relatively thin (10 metres), and are found close to major river valleys. Gartner Lee and Associates (1983) suggested that outwash plains, generally, are suitable for traffic gravel, base course, aphaltic gravel etc.

FLUVIAL TERRACES

Flurral terraces are located along rivers and former meltwater channels. The terraces are flat, commonly occur as long narrow deposits along valley sides or bottoms, and consist predominantly of sand and gravel. Deposit thicknesses vary from 2 to 10 metres and vary considerably in terms of their gravel content.

MELTWATER CHANNEL

Small meltwater channel deposits are scattered throughout the till plain and represent a minor surface washing of the till plain by meltwater. The meltwater eroded small channels in the till plain and occasionally deposited a small body of sand. These deposits are generally not significant in terms of aggregate potential and are often used for fill.

ESKER-KAMES

One esker deposit (12207) and one kame deposit (12208) were identified. The esker and kames occur as small isolated exposures, contain a high sand content, and are overlain by till. Selective extraction has occurred from these deposits with the material being primarily utilized for municipal road maintenance.

3.3 DEMAND FOR SAND AND GRAVEL

The demand for sand and gravel is tied closely to activity in the construction sector. This type of a relationship betweeen an input and output of a final product is referred to as derived demand where the sand and gravel is produced to meet the required needs of the construction industry, with most of the aggregate consumed in public sector highway and road construction activities. Consequently, the demand or extraction rate is a function of end use requirements and is directly related to both the level and mix of regional construction-related activities.

The long term demand for sand and gravel is highly inelastic primarily because there is no engineering substitute for most end uses. The long-term implications of a resource that possesses poor technical substitution with a demand relationship that is highly inelastic imply that future requirements for roads and other engineering projects will cost more to build with the increased cost of production being absorbed by the consumer rather than the producer. The long term cumulative demand for aggregate is anticipated to continue to grow due to the maintenance requirements of existing structures as well as to supply the essential ingredients in new forms of social and private capital.

Aggregate is a large volume, high-bulk, low-value construction material that substitutes for other more expensive materials such as wood, steel, plastic, etc. One significant resource management concept is the relationship between quality, quantity demanded, and delivered price. As

higher quality deposits are depleted or sterilized, lower quality resources will become significantly more valuable.

The estimated demand for aggregate is based on consideration of

(1) Department of Highways upgrading and improvements for the next 25 years in the R.M. of Russell
(2) municipal requirements for Russell; and
(3) requirements for redi-mix concrete and other private interests

The estimated demand for aggregate is presented in Table 3.1

TABLE 3.1

ESTIMATED ANNUAL DEMAND FOR SAND AND GRAVEL IN THE RURAL MUNICIPALITY OF RUSSELL (m^3)

END USER	1 YEAR	25 YEARS
Department of Highways	6 580	190 000
R.M. of Russell	7 600	164 500
Private	2 100	52 500
	16 280	407 000

The demand for sand and gravel in the R.M. of Russell has been estimated to be 407 000 cubic metres for the next 25-year planning period. The aggregate will be required to facilitate future construction projects including end uses such as concrete, asphalt, other engineering construction and fill. Local consumption of aggregate includes municipal road maintenance, septic field construction, sewer pipe bedding, foundations, and sidewalks. Highway improvements include Provincial Trunk Highways and Provincial Roads.

The above noted demand accounts for the aggregate requirements in the Rural Municipality of Russell. The estimated demand does not account for a major construction project such as a potash mine. If such an event were to occur it would consume a large quantity of aggregate resources.

3.4 RECOMMENDED DEVELOPMENT STATUS OF MINERAL RESOURCE AREAS

The sand and gravel deposits are shown on Map 1 (in pocket). The resource information utilized in the background study is based on geologic mapping by Gartner Lee and Associates Ltd. in 1983. A total of 16 deposits were identified containing an estimated 122 million cubic metres of resource.

The following recommendations for protection of sand and gravel deposits in the R.M. of Russell are designed to ensure that the supply of aggregate is available for future use. Land-use planning should recognize the potential for conflict between mineral resource extraction and other surface land uses (see Appendix II). Furthermore, surface land uses which restrict or prohibit development of the gravel resources should not be permitted. In order to delineate gravel deposits, where conflicting surface land uses should be restricted, the Stop-Caution-Go development status is presented on Map 1 (in pocket and Table3 3 .2). This recommended deposit status is based on:

(1) size and quality of the deposit;
(2) present and past use of the resource;
(3) location (in relaxation to access, transportation routes, and existing land holdings
(4) the objectives for pit and quarry operation and rehabilitation, as outlined in Appendix II of this report; and
(5) the overall regional requirements for supply and demand for aggregate

In a manner consistent with Provincial Land Use Policy #13, the Stop development status indicates a valuable deposit upon which no conflicting surface land-uses should be permitted. Conflicting surface land-uses should

be permitted. Conflicting surface land-uses include housing (subdivision of lots for residential use), or the imposition of highways or utility corridors over the deposits. Such development should be deferred until the resource is mined to depletion and the site rehabilitated. The Caution development status denotes a deposit whose full potential is not proven, or where quality is not high, but has been recognized as potentially valuable to a region. Deposits assigned a Caution Development status should be referred to the Aggregate Resources Section when conflicting surface land uses occur. Deposits that are either of low quality or those that have been depleted are assigned a Go Development status. These deposits are not considered important in terms of future resource utilization.

TABLE 3.2

AGGREGATE RESOURCES IN
THE RURAL MUNICIPALITY OF RUSSELL

DEPOSIT	LANDFORM TYPE TYPE	QUALITY	ESTIMATED RESERVES (m^3)	RECOMMENDED DEVELOPMENT STATUS
12201	Small Meltwater Channel	Medium	90 000	Caution
12202	Small Meltwater Channel	Medium-high	102 200	Stop
12203	Fluvial Terrace	Medium	36 000	Stop
12204	Fluvial Terrace	Medium	2 739 000	Stop
12205	Small Meltwater Channel	Medium	221 000	Stop
12206	Small Meltwater Channel	High	14 000	Caution
12207	Esker	Medium-high	195 000	Caution
12208	Buried (unknown)	Medium-low	67 000	Caution
12209	Kame	Medium-low	325 000	Caution
12210	Fluvial Terrace	Medium-high	11 787 000	Stop
12211	Fluvial Plain outwash	High	98 892 000	Caution
12212	Buried	Medium-high	168 000	Stop
12213	Fluvial Terrace	Medium low to Medium-high	6 532 500	Caution
12214	Fluvial Terrace	Medium-high	502 500	Stop
12215	Buried	Medium-high	9 000	Caution
12216	Fluvial Terrace	Medium-low	870 000	Caution
TOTAL			122 550 700 m^3	

3.5 CONCLUSION

An estimated total of 122 550 700 cubic metres of recoverable aggregate have been identified in the Rural Municipality of Russell. This resource will be required in order to meet the needs of the local construction industry. The Rural Municipality of Russell has sufficient aggregate resources to meet local demand for the foreseeable future but the resource is not evenly distribution throughout the municipality. It is recommended that all deposits assigned a Stop development status be protected from conflicting surface land uses until the resource has been mined to depletion.

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APPENDIX I

MANITOBA REGULATION 217/80 OF THE PLANNING ACT

PROVINCIAL LAND USE POLICY #13

POLICY #13

ECONOMICALLY VALUABLE AGGREGATE AND QUARRY MINERAL DEPOSITS SHOULD BE PROTECTED FROM SURFACE LAND USES THAT WOULD INTERFERE WITH THEIR ONGOING AND FUTURE EXPLOITATION.

A. Policy Objectives

The objectives of this Policy are:

(a) To protect aggregate and quarry mineral resources for future construction and development in the Province.
(b) To ensure that materials are available to support local and provincial construction needs and industrial minerals production at a reasonable cost.
(c) To ensure that pit and quarry operations are reasonably compatible with adjacent land uses.
(d) To integrate aggregate and quarry mineral extraction into the overall land use planning process by allocating areas specifically for extraction and by assuming that as the economic climate changes so areas allocated to resource extraction will also change.
(e) To pursue sequential land use practices such that on a known deposit (i) a non-conflicting land use is applied to the surface of the deposit prior to mineral extraction, and (ii) the land is returned to a practical and compatible use once extraction has ceased.

B. Policy Application

Deposits of sand and gravel and near-surface limestone which are in demand as construction materials by industry, local communities or government departments and agencies, should be protected. In certain parts of the Province such minerals as bentonite, shale, gypsum, high calcium limestone, silica sand and other quarry minerals should also be protected to ensure a supply of these materials to industrial mineral related industries. These include both surface deposits and shallow subsurface deposits overlain by till or clay.

For the purpose of this Policy:

(a) Conflicting land uses include residential subdivision lots, highways or utility corridors. Such development should be deferred until the mineral is extracted and the site rehabilitated.
(b) Marginally conflicting land uses include the incorporation of aggregate and quarry mineral deposits into a Provincial or National Park, a Wildlife Management Area, a Community Pasture or a Provincial Forest or the establishment of a garbage dump on part of a deposit. In these cases, mineral extraction can take place alongside the alternative land use, provided that agreement is reached between the two concerns, to ensure optimal utilization of all resources involved.
(c) Non-conflicting land uses include recreation outside of Provincial Parks, low value timber stands, general agricultural practices and temporary occupation, such as trailer parks or parking lots. Pit and quarry operations can develop in these areas whenever such activities become economically feasible.

In some areas aggregate or quarry mineral extraction should be recognized as a primary land use. In other areas a marginal or non-conflicting land use may be permitted providing that it could later be converted to a gravel or mineral extraction operation.

In order to indicate areas where conflicting land uses should be disallowed, the Mineral Resources Division is in the process of producing aggregate and quarry mineral resource maps for certain regions of the Province. These will take the form of "Stop – Caution – Go" maps. "Stop" indicates valuable deposits upon which no conflicting land use should be allowed. "Caution" denotes a deposit whose full potential is not proven or whose quality is not high but which has been recognized as of value to the region. Deposits with a status of "Caution" may be designated for a conflicting land use, after local needs have been scrutinized. "Go" denotes a deposit of no present recognized value as an aggregate or quarry mineral source. Periodic revision to the "Stop – Caution – Go" status of deposits will reflect continuing exploration and changing economic

conditions. It is understood that the maps will be subject to approval by the Provincial Land Use Committee.

The rehabilitation of pits and quarries on both Crown and private land is governed by Regulation under The Mines Act. The rehabilitation takes place in accordance with an approved plan. Concensus for the plan is derived from concerned Municipal and Provincial agencies. The Mineral Resources Division requires such plans from all commercial operators.

Following mineral exploitation and rehabilitation, the land can be restored to some compatible use.

C. Definitions

For the purpose of this Policy:

(a) "Aggregate" means sand, gravel, or both, or crushed rock.

(b) "Economically Valuable Aggregate and Quarry Mineral Deposits" means those areas of aggregate and quarry mineral resource which have a high potential for extraction based on supply and demand projected over 25 years.

(c) "Quarry Minerals" means those minerals obtained by quarrying, including shale, kaolin, bentonite, gypsum, clay, silica-rich sand, peat, salt, coal, and rock or stone used for any purpose other than as a source of metal, asbestos, potash, oil and natural gas.

APPENDIX II

MINING OF AGGREGATE AS A LAND USE

MINING OF AGGREGATE MINERALS AS A LAND USE

1.0 INTRODUCTION

Pits and quarries represent a unique land use warranting special consideration in the preparation of any municipal development plan. This status may be attributed to the following inherent characteristics of surface-mining:

(i) The fullest possible exploitation of mineral reserves in proximity to the market is desirable since aggregate products are non-renewable and essential to our society..

(ii) As both a land use and a user of land, open surface mines can create environmental conflicts affecting adjoining property. By its very nature surface mining can be a source of noise, dust, vibrations, vehicle (truck) traffic, steep embankments, dangerous open water conditions, and general visual degradation.

(iii) Upon discontinuation of excavation, alternative uses for the mine landscape must be considered. Pits and quarries are an interim land use. The large-scale manipulation of the landscape to win aggregate deposits can present opportunities

which enhance the potential for subsequent land uses. While it may be impossible to totally restore the pre-mining conditions of a site, it may be even more advantageous to exploit these new opportunities.

2.0 Mining Dispositions and Land Tenure

2.1 Responsibility for Rehabilitation:

The requirements of The Mines Act and any of its regulations are binding upon the operator of a mine and the owner or lessee of the mineral rights, who initiates the mining and derives the main benefits of any returns. This may exclude the owner of surface rights, if he does not hold the mineral rights. Although the mineral and surface rights are commonly held together, there are instances where they have been separated in previous transactions or to facilitate mining. There are locations, for example, where the Crown holds one but not the other.

Manitoba Regulation 226/76, which sets out rehabilitation requirements, applies only to those pits and quarries which have been worked since January 1977. This authority is not binding for mines worked out prior to this date.

2.2 Pits and Quarries on Crown Land vs. Private Land

Where the Crown owns the surface rights, the condition of the post mining landscape is of direct concern since the Crown is responsible for subsequent use of the site. Consequently, provincial agencies take an active role in the preparation of mining and rehabilitation plans for such mines.

The disposition of mining rights on Crown land may be handled in any of two ways:

(i) A "Casual Permit" or a "Permission to Remove" may be obtained from the Mineral Resources Division to remove a specific quantity of aggregate from a specific site.

(ii) A "lease" may be obtained for a period of ten years (renewable) on lands open for staking.

On privately owned land, the advantages of developing a productive post-mining land use are returned largely to the holder of surface property rights, in the form of both ongoing productivity and increased equity. Consequently, the main focus of concern for provincial authorities in these instances is to ensure that adjoining property will not be detrimentally affected by the mining activity, and that any hazards to the public are minimized.

In recognition of these characteristics, regulations have been enacted under The Mines Act since 1976 directed

toward rehabilitation of all commercial quarries.* Rehabilitation may be broadly defined as the planned excavation and progressive reclamation of a mine site based on objectives of:

(i) minimizing hazards to public safety

ii) protecting the environment

(iii) optimizing the productivity of the post-mining landscape for some social or economic purpose

(iv) efficiently utilizing the available resources.

The central focus of provincial legislation is to establish controls achieving safe operation and reclamation of mines, while minimizing detrimental environmental impact. The established standards are generally minimums, which may be insufficient in special circumstances. The role of the municipality in exerciting their authority under The Planning Act should be to direct the location of future mine development, and, where necessary, establish controls above and beyond those currently enacted.

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* A commercial quarry as defined by Manitoba Regulation 226/76 means a pit or quarry from which more than 2,000 cubic yards of mineral are removed annually and which is operated for any purpose except for the personal use of an owner who is a natural person.

2.3 Mechanisms of Rehabilitation:

2.3.1 Mining Conditions:

Casual Permits and Permissions to Remove are issued subject to certain conditions which direct mining on the site and require appropriate rehabilitation. These conditions are based on strategies or rehabilitation plans prepared for each Crown pit or quarry subject to such applications.

2.3.2 Submission of Plans and Information

In the case of lease holders, and commercial mines on private property, Manitoba Regulation 226/76 requires the submission of information concerning the proposed mine operation and rehabilitation. The scope of such submissions is outlined in the attached form (Appendix I). These plans are reviewed by the Mining Engineering and Inspection Section in general consultation with local municipal officials and other government departments who provide expertise in various fields (i.e., groundwater, forestry, agriculture, highways, wildlife, etc.) or may assume responsibility for management of the post-mining landscape.

2.3.3 Enforcement

All mining activities in the Province are monitored by mines inspectors. Consultation with operators and the issue of

'orders' are means used to bring operations into compliance with The Mines Act and its regulations. The legislation provides for fines to be imposed for any contravention. In addition, commercial mine operators are required to put up a bond which is held by the Crown pending completion of the rehabilitation requirements.

3.0 Criteria for Rehabilitation

3.1 General Criteria

The evaluation of rehabilitation plans and establishment of mining conditions is generally based on the following broad criteria:

(i) any detrimental impact on the environment caused by the mine operation or the resultant mine landscape will be minimized to an acceptable level by controlling the extent and/or phasing of the operation and by implementing appropriate remedial measures

(ii) the operation of the mine and the reclamation of the landscape will mitigate any undue hazards to public safety

(iii) efficient use will be made of topsoil, overburden and reject material to facilitate progressive reclamation which will accommodate an appropriate end use.

3.2 Specific Considerations:

Within the context of such criteria, there are a wide range of specific concerns which will obviously vary from site to site. The following are a few of the major considerations:

(i) Setback:

Many of the conflicts arising from surface mining can be resolved by providing a separation distance between mine excavation or stockpiles and the property boundary. Since such restrictions may have the effect of tying up portions of a mineral deposit, this cost should be balanced against any benefits derived.

The Highways Protection Act imposes a setback of 125 feet from a department road, and 250 feet from a designated highway, subject to appeal. Regulations under The Mines Act specify a setback of 50 feet from other property boundaries, unless agreement is reached with the adjoining party. As a general minimum, a distance of 10 feet plus three times the height of an unconsolidated working face, and at

least twice the height of a consolidated working face will provide sufficient room for slope reclamation while minimizing the loss of material.

In local circumstances where a mineral deposit abuts existing development which is clearly sensitive to the characteristics of surface mining, the Municipality may want to consider the establishment of setback controls substantially exceeding those under the Provincial authority as a condition of allowing mining.

(ii) Environmental Protection:

The general criteria for protection of the environment have been established by Provincial statutes, regulations and guidelines, and are administered by various Provincial agencies. For example, the Water Rights Act regulates treatment of surface and groundwater, while emissions of noise, dust and vibration are regulated under The Clean Environment Act.

From the standpoint of surface mining, the main concern is to identify and resolve any problems before they occur, as part of a pre-planning stage. The impact of mining can be substantially reduced where it is subject to requirements for additional setback, berms, tree screens and/or careful phasing

of the operation followed by slope stabilization and revegetation. The effectiveness of such mechanisms should be evaluated carefully by a municipality before consideration is given to prohibiting mining at a new location for environmental reasons. Mining is an interim land use, often of short duration. While it may be unacceptable in some circumstances, the interests of the municipality are best served by maximizing utilization of the available aggregate reserves.

(iii) Public Safety:

The creation of steep slopes and new water bodies as a result of surface mining activity poses special problems of public safety. In pits, the unconsolidated material can be re-graded to a stable and traversable angle as a component of the rehabilitation program, thereby minimizing the safety hazard. However, the cost of grade modification in quarries is often prohibitive, due to difficulties in manipulating consolidated material and the inavailability of overburden. Under this circumstance, fences, berms and signage are tools used to inform persons of the dangerous conditions and prevent inadvertent access.

(iv) End Land Use:

In some instances it will be impractical to return a mining site to its pre-mining condition, particularly in terms of biological productivity. However, it is in the public interest to promote productive use of the landscape, as opposed to accepting dereliction. There are opportunities to enhance environmental conditions for alternative uses by a by-product of the large-scale manipulation of the mine site. The central concern here is that rehabilitated slopes on the mine site are appropriate for the intended use (see Table 1), and that this intended use does not conflict with the development pattern established by the municipality.

Where a major mineral deposit is being worked, and it is expected that mining will continue for many years, designation of a specific post-mining land use may be premature. In these circumstances interim rehabilitation should be directed toward optimizing the potential for the widest range of uses foreseeable. In time the options can be narrowed to facilitate more detailed site planning.

4.0 Municipal Concerns and Policy Recommendations:

Given the limitations of any controls established on a province-wide basis under The Mines Act, it is recommended that municipalities exercise their planning authority to properly accommodate mining as a land use in the local context. The following policy objectives are suggested for this purpose:

1. In any area where a mineral deposit is located adjacent to existing development which would clearly be sensitive to the impact of surface mining, the Municipality should, in consultation with the Mineral Resources Division, enact controls limiting the extent of mining and establish appropriate conditions for operation beyond those required under The Mines Act and its regulations, which will have the effect of mitigating any undue environmental conflicts.

2. To minimize any future conflict between mineral resource exploitation and other land uses which would be sensitive to the inherent characteristics of surface mining, such sensitive land uses should not be allowed within 1000 feet of the anticipated limits of mining activity. This would include, but not be limited to, seasonal or permanent residential uses, as well as certain institutional, commercial and recreational uses.

3. All local roads which now carry high volumes of truck traffic from a surface mine, or which may be anticipated to eventually carry high volumes of truck traffic upon commencement of mining a particular mineral deposit, should be protected from any adjoining development which would be sensitive to such traffic by:

   i) precluding development of any such land uses, or

   ii) establishing setback, screening, and ingress/egress controls which would mitigate the impact of high volumes of truck traffic.

4. The mining of aggregate is recognized as a transitional and interim land use. Consideration should be given to pre-zoning a mine site for the sequential development of other activities which take advantage of opportunities inherent in the rehabilitated landscape, provided:

   i) the owner of the mine provides plans, schedules and information regarding the eventual condition of the mining site upon completion of excavation and rehabilitation;

   ii) the owner of the mine demonstrates the oppropriateness of such a use to the post-mining site and local conditions.

5. To take advantage of any opportunities inherent in the rehabilitation of local pits and quarries on Crown Land, the municipality should participate with other Crown agencies in the selection of post-mining land uses on such sites and have input to the development of appropriate rehabilitation plans.

TABLE 1

SLOPE LIMITATIONS FOR LAND USE

50% (2:1)	Can be climbed on foot, but is difficult to establish stabilizing vegetation.
30% (3:1)	Maximum slope traversed by tractor for seeding or mowing; expert ski slope; forestry, wildlife area.
20% (5:1)	Limit of economical agriculture activity, toboggan slope, beginners ski slope; maximum shore slope for easy wading.
15% (6 1/2:1)	Low density single family residential; golf course; maximum sustained slope for roads.
10% (10:1)	Single family developments (medium density) preferred maximum road slopes; limits of most commercial and industrial uses.
5% (20:1)	Preferred slope for most residential, commercial and industrial development; beaches/swimming shores.
1% (100:1)	Minimum slope to ensure surface drainage.

APPENDIX III

EXAMPLES OF AGGREGATE RESOURCE DATA

AVAILABLE FOR THE RURAL MUNICIPALITY OF RUSSELL

PROVINCE OF MANITOBA - AGGREGATE RESOURCES

DEPOSIT 012210

TOWN	RANGE	SECTION	QUARTER	OUTWASH TERRACE		OUTWASH CHANNEL	
019	29W	28	NE	3,000	CU.M.	27000	CU.M.DEPL/NOT AVAIL
			NW	180,000	CU.M.	540000	CU.M.DEPL/NOT AVAIL
		33	NE	54,000	CU.M.	486000	CU.M.DEPL/NOT AVAIL
			NW	1,350,000	CU.M.	450000	CU.M.DEPL/NOT AVAIL
			SW	1,560,000	CU.M.		CU.M.DEPL/NOT AVAIL
020	29W	03	NE	97,500	CU.M.	292500	CU.M.DEPL/NOT AVAIL
			NW	1,290,000	CU.M.	1290000	CU.M.DEPL/NOT AVAIL
			SW	765,000	CU.M.	765000	CU.M.DEPL/NOT AVAIL
		04	NE	120,000	CU.M.		CU.M.DEPL/NOT AVAIL
			SE	2,295,000	CU.M.	765000	CU.M.DEPL/NOT AVAIL
			SW	292,500	CU.M.	97500	CU.M.DEPL/NOT AVAIL
		10	NW	1,740,000	CU.M.		CU.M.DEPL/NOT AVAIL
			SW	2,040,000	CU.M.		CU.M.DEPL/NOT AVAIL

DEPOSIT RESERVES 11,787,000 CU.M.

PROVINCE OF MANITOBA - AGGREGATE RESOURCES

DEPOSIT 012211

TOWN	RANGE	SECTION	QUARTER	OTHER (DESCRIBE)	OUTWASH CHANNEL
018	29W	31	NE	1,560,000 CU.M.	CU.M.DEPL/NOT AVAIL
			NW	840,000 CU.M.	CU.M.DEPL/NOT AVAIL
			SE	1,040,000 CU.M.	CU.M.DEPL/NOT AVAIL
			SW	20,000 CU.M.	CU.M.DEPL/NOT AVAIL
		32	NE	2,400,000 CU.M.	CU.M.DEPL/NOT AVAIL
			NW	140,000 CU.M.	CU.M.DEPL/NOT AVAIL
			SE	1,480,000 CU.M.	CU.M.DEPL/NOT AVAIL
		33	NW	1,320,000 CU.M.	CU.M.DEPL/NOT AVAIL
			SW	360,000 CU.M.	CU.M.DEPL/NOT AVAIL
019	29W	03	NW	880,000 CU.M.	CU.M.DEPL/NOT AVAIL
			SW	1,920,000 CU.M.	CU.M.DEPL/NOT AVAIL
		04	NE	2,560,000 CU.M.	CU.M.DEPL/NOT AVAIL
			NW	1,080,000 CU.M.	CU.M.DEPL/NOT AVAIL
			SE	2,240,000 CU.M.	CU.M.DEPL/NOT AVAIL
			SW	40,000 CU.M.	CU.M.DEPL/NOT AVAIL
		05	NE	1,080,000 CU.M.	CU.M.DEPL/NOT AVAIL
			NW	2,560,000 CU.M.	CU.M.DEPL/NOT AVAIL
			SE	1,880,000 CU.M.	CU.M.DEPL/NOT AVAIL
			SW	2,040,000 CU.M.	CU.M.DEPL/NOT AVAIL
		06	NE	2,560,000 CU.M.	CU.M.DEPL/NOT AVAIL
			NW	2,560,000 CU.M.	CU.M.DEPL/NOT AVAIL
			SE	2,560,000 CU.M.	CU.M.DEPL/NOT AVAIL
			SW	2,560,000 CU.M.	CU.M.DEPL/NOT AVAIL

PROVINCE OF MANITOBA - AGGREGATE RESOURCES

DEPOSIT 012211

TOWN	RANGE	SECTION	QUARTER	OTHER (DESCRIBE)	OUTWASH CHANNEL
		07	NE	2,560,000 CU.M.	CU.M.DEPL/NOT AVAIL
			NW	2,560,000 CU.M.	CU.M.DEPL/NOT AVAIL
			SE	2,560,000 CU.M.	CU.M.DEPL/NOT AVAIL
			SW	2,560,000 CU.M.	CU.M.DEPL/NOT AVAIL
		08	NE	2,560,000 CU.M.	CU.M.DEPL/NOT AVAIL
			NW	2,560,000 CU.M.	CU.M.DEPL/NOT AVAIL
			SE	2,560,000 CU.M.	CU.M.DEPL/NOT AVAIL
			SW	2,560,000 CU.M.	CU.M.DEPL/NOT AVAIL
		09	NW	1,200,000 CU.M.	CU.M.DEPL/NOT AVAIL
			SE	240,000 CU.M.	CU.M.DEPL/NOT AVAIL
			SW	2,280,000 CU.M.	CU.M.DEPL/NOT AVAIL
		16	SW	100,000 CU.M.	CU.M.DEPL/NOT AVAIL
		17	NE	280,000 CU.M.	CU.M.DEPL/NOT AVAIL
			NW	2,240,000 CU.M.	CU.M.DEPL/NOT AVAIL
			SE	2,000,000 CU.M.	CU.M.DEPL/NOT AVAIL
			SW	2,560,000 CU.M.	CU.M.DEPL/NOT AVAIL
		18	NE	2,560,000 CU.M.	CU.M.DEPL/NOT AVAIL
			NW	2,560,000 CU.M.	CU.M.DEPL/NOT AVAIL
			SE	2,560,000 CU.M.	CU.M.DEPL/NOT AVAIL
			SW	2,560,000 CU.M.	CU.M.DEPL/NOT AVAIL
		19	NE	2,560,000 CU.M.	CU.M.DEPL/NOT AVAIL
			NW	2,560,000 CU.M.	CU.M.DEPL/NOT AVAIL

PROVINCE OF MANITOBA - AGGREGATE RESOURCES

DEPOSIT 012211

TOWN	RANGE	SECTION	QUARTER	OTHER (DESCRIBE)		OUTWASH CHANNEL	
019	29W	19	SE	2,560,000	CU.M.		CU.M.DEPL/NOT AVAIL
			SW	2,560,000	CU.M.		CU.M.DEPL/NOT AVAIL
		20	NE	1,152,000	CU.M.	6000	CU.M.DEPL/NOT AVAIL
			NW	1,520,000	CU.M.		CU.M.DEPL/NOT AVAIL
			SW	1,360,000	CU.M.		CU.M.DEPL/NOT AVAIL
		29	NW	800,000	CU.M.		CU.M.DEPL/NOT AVAIL
			SE	640,000	CU.M.		CU.M.DEPL/NOT AVAIL
			SW	2,480,000	CU.M.		CU.M.DEPL/NOT AVAIL
		30	NE	2,400,000	CU.M.		CU.M.DEPL/NOT AVAIL
			NW	2,560,000	CU.M.		CU.M.DEPL/NOT AVAIL
			SE	2,560,000	CU.M.		CU.M.DEPL/NOT AVAIL
			SW	2,560,000	CU.M.		CU.M.DEPL/NOT AVAIL
		31	SE	1,240,000	CU.M.		CU.M.DEPL/NOT AVAIL
			SW	800,000	CU.M.		CU.M.DEPL/NOT AVAIL
		32	SW	440,000	CU.M.		CU.M.DEPL/NOT AVAIL

DEPOSIT RESERVES 108,052,000 CU.M.

PROVINCE OF MANITOBA - AGGREGATE RESOURCES

EXPOSURE G 002 (012208 020 28W 34 SW) VISITED

BORROW PIT AGRICULTURE, HAYING

.0 M.

SECTION A GEOLOGIST AC SECTION HEIGHT 5.0 M. EXAMINED 4.0 M.

BASE SAME AS IN PIT WALL WATER TABLE 5.0 M.

LITHOLOGY 50 % GENERAL CARBONATES 30 % SHALES

DELETERIOUS SHALE

SAMPLE-- COBBLES % PEBBLES 23.69 % GRANULES 4.84 % SAND 5.90 % SILT/CLAY 65.57 %

EXPOSURE G 002 (012208 020 28W 34 SW) - VISITED

BORROW PIT AGRICULTURE, HAYING

.0 M.

SECTION B GEOLOGIST AC SECTION HEIGHT 3.5 M. EXAMINED 3.5 M. -

BASE SAME AS IN PIT WALL WATER TABLE .0 M. -

LITHOLOGY 60 % GENERAL CARBONATES 25 % GRANITIC TYPES

DELETERIOUS SHALE

SAMPLE-- COBBLES --- % PEBBLES --- % GRANULES --- % SAND --- % SILT/CLAY --- % -

PROVINCE OF MANITOBA - AGGREGATE RESOURCES

EXPOSURE G 150 (012207 020 28W 31 SE) VISITED

ROAD CUT OR DITCH SECTION AGRICULTURE, HAYING

.0 M.

SECTION A GEOLOGIST BH SECTION HEIGHT 4.5 M. EXAMINED 3.5 M.

BASE BEDROCK WATER TABLE .0 M.

LITHOLOGY 65 % SHALES 0 %

DELETERIOUS SHALE

SAMPLE-- COBBLES % PEBBLES 48.97 % GRANULES 17.27 % SAND 24.62 % SILT/CLAY 9.15 %

EXPOSURE G 150 (012207 020 28W 31 SE) - VISITED

ROAD CUT OR DITCH SECTION AGRICULTURE, HAYING

.0 M.

SECTION B GEOLOGIST BH SECTION HEIGHT 4.0 M. EXAMINED 3.0 M. -

BASE TILL WATER TABLE .0 M. -

LITHOLOGY 80 % GENERAL CARBONATES 20 % ULTRABASIC TYPES

DELETERIOUS SHALE

SAMPLE-- COBBLES --- % PEBBLES --- % GRANULES --- % SAND --- % SILT/CLAY --- % -

APPENDIX IV

POTASH RESOURCE POTENTIAL IN THE RURAL MUNICIPALITY OF RUSSELL

R.M. OF SHELLMOUTH

31

12201 C

12202

12203C

TP.21

SMITH CREEK

12204

36

31

CANADIAN

254

36

RAILWAY

83

GAS PIPELINE

MADILL

CONJURING

NATIONAL

CREEK

TOWN OF RUSSELL

RAILWAYS

SASKATCHEWAN

6

12205 C

CANADIAN

4

31

12206 C

36

31

1

6

4

45

AIRPORT

1

36

SASKATCHEWAN

TP. 20

PROVINCE OF MANITOBA

R.M. OF SILVER CREEK

6 | 1 | 6 | 1

31 | 36 | 31 | 36

6 | 1 | 6 | 1

31 | 36 | 31 | 36

6 | 1 | 6 | 1

12205 C

12206 C

12207

12208 C

12209

12210

12211

12212 C

12213

CANADIAN

ASSINIBOINE

HARROWBY

TOWN OF RUSSELL

AIRPORT

RAILWAYS

PACIFIC

PACIFIC

MILLWOOD

RIVER

CANADIAN

GAS PIPELINE

4

4

45

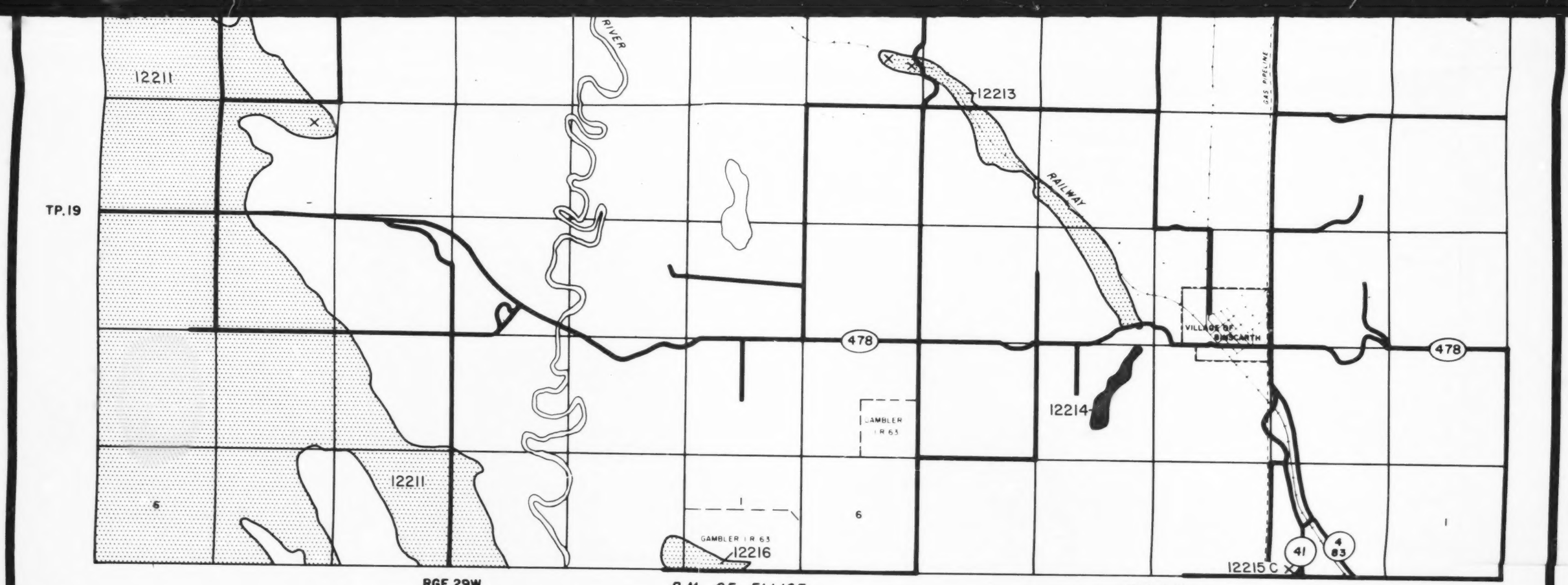
579

579

579

4-83

479



RECOMMENDED DEVELOPMENT STATUS OF AGGREGATE DEPOSITS IN THE R. M. OF RUSSELL

LEGEND

STOP

CAUTION

SYMBOLS

× GRAVEL PIT

12211 DEPOSIT NUMBER

Manitoba
Energy and Mines

0 1 2 miles

SCALE 1:50,000